be done using liquid either alone or in combination with "barium hamburger" patties; these require serial abdominal radiographic films (normally for six hours after the solid barium hamburger consumption).

More palatable, comfortable and physiologic studies using natural foods can be done with nuclear studies. The key to the nuclear medicine techniques is to affix a radiotracer to either a liquid or a solid material for assessing and accurately quantitating rates of emptying. The radiotracers are used in minute quantities and never affect the taste of the food. The solid phase of the study is usually applied by tagging scrambled egg for consumption as an omelet sandwich. For the liquid phase, 300 ml of a tagged liquid, such as orange juice, is used. The radiolabels have been found to be stable in vitro and in vivo. Liquid and solid meal studies can be done simultaneously by using two different radioisotopes. After the patient consumes the meal, sequential acquisitions are made with a gamma camera and stored in a computer. Regions of interest are then drawn around the stomach only. Counts from this area are obtained for each sequential accumulation and a graph of the counts versus time is drawn and can be extrapolated. The decreasing counts with time represent the rate of gastric emptying. The liquid study alone takes about 20 minutes of acquisition, while the solid or combined study is usually extended out to 90 minutes.

The normal time to empty half of each tagged material consumed (T½) is about 10 minutes for the liquid phase and 60 to 90 minutes for the omelet sandwich. An accelerated T½ reflects an abnormality such as a dumping syndrome. Conversely, a prolonged T½ reflects one of the several disorders associated with abnormal gastric retention.

Repeat studies are often helpful in evaluating the efficacy of therapy, such as a surgical procedure or the use of metoclopramide hydrochloride.

The nuclear studies described are physiologic and palatable. The amount of irradiation is less than in a barium hamburger meal and the study is more comfortable than a saline load test. A major advantage is the ability to provide more elaborate quantitative data; furthermore, unpalatability can, in itself, produce misleading results.

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Thyroid Cancer—Treatment Phase

ALTHOUGH MOST THYROID ADENOCARCINOMAS can be removed surgically, there is often uncertainty as to the completeness of the resection and the presence of local or distant metastases. For more than 35 years, radioiodine (iodine 131) has been used as adjunctive therapy in tumors that are of the differentiated cell type—papillary and follicular adenocarcinomas. It is the objective of radioiodine treatment to destroy all thyroid cancer tissue. The ability of residual or metastatic thyroid cancer to concentrate radioiodine is directly related to the serum thyroid stimulating hormone (TSH) concentration. Optimally, serum TSH levels should exceed 40 μU per ml. In the rare instances when TSH levels do not rise, exogenous bovine TSH may need to be given. Once adequate tumor uptake has been assured by radioiodine imaging studies, most nuclear medicine therapists recommend administering a fixed amount of radioiodine that varies from 100 to 200 mCi, depending on the extent of tumor distribution.

Following total thyroid cancer ablation, radioiodine imaging is ordinarily done at yearly intervals for three years and biennially thereafter for a minimum of ten years. If there is tumor recurrence, the patient is re-treated.

Whole-body imaging with radioiodine has been considered the most sensitive means of detecting recurrent disease. It is a formidable procedure, however, requiring withdrawal of thyroid hormone replacement therapy and periods of symptomatic hypothyroidism. Recent reports suggest that the determination of the serum thyroglobulin level may be as sensitive in detecting recurrent thyroid cancer as radioiodine imaging and may supplement or even replace it. Because most thyroid adenocarcinomas secrete thyroglobulin, a significantly elevated level in a patient receiving thyroid hormone replacement is a clear indication for radioiodine imaging. Low levels appear to exclude the presence of recurrent thyroid carcinoma. Patients who have borderline elevations of serum thyroglobulin should be restudied with radioiodine after withdrawal of thyroid hormone. At the present time, the measurement of thyroglobulin levels is best considered complementary to radioiodine imaging in the management of thyroid cancer patients.

Despite 35 years of experience, the therapeutic efficacy of radioiodine in the management of thyroid adenocarcinoma remains controversial. A number of reports have appeared in recent years, however, that indicate increased survival and decreased tumor recurrence in patients who have received radioiodine therapy. The most favorable results have been obtained in patients with cervical or mediastinal lymph node involvement and thyroid bed residuals. Results have been less rewarding in patients with surgically unresectable tumor and gross residual disease and in patients with skeletal involvement. Accordingly, in some patients, limited or no therapeutic benefit is obtained with radioiodine therapy, whereas in others, large disseminated tumor masses disappear and no evidence of recurrence of tumor tissue can be shown after 20 years of follow-up. In view of this variability in response, it is important that radioiodine therapy be used judiciously in the appropriate clinical situation and for the histologic type of tumor that can be expected to be clinically responsive.

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Radionuclide Diagnosis of Varicocele in Infertility

INFERTILITY HAS BEEN REPORTED to occur in as many as 15% of the normal population, and male infertility has been cited as the major cause in 30% to 50% of childless marriages.

Within this group of subfertile men, a scrotal varicocele has been identified as a well-established cause of decreased testicular function. It is also the most common surgically correctable cause of subfertility in men. While present in about 15% of the normal male population, the incidence is much higher (30% to 40%) in subfertile men, and surgical correction is associated with improvement in fertility in a large number of such patients.

Anatomically, a varicocele is caused by unimpeded retrograde venous flow in the internal spermatic vein, with subsequent dilatation of the pampiniform plexus. It is frequently associated with incompetence of the venous valves of the spermatic vein. It occurs on the left side in about 85% of cases and is occasionally bilateral, but rarely right-sided only.

The specific cause of abnormal testicular function in association with a varicocele is not established. It is most often felt to reflect a disturbance in the temperature regulation and an increase in scrotal temperature, but it may be due to retrograde flow of adrenal metabolites and renal hormones through the renal vein into the spermatic vein, affecting spermatogenesis. Collateral circulation connecting the venous system of the right and left testes would account for a bilateral effect from a unilateral abnormality.

A varicocele is frequently diagnosed by manual examination alone, based on palpability of the dilated pampiniform plexus (frequently during a Valsalva's maneuver), possibly in association with a decrease in the size of the ipsilateral testis. Physical examination, however, is not specific or highly sensitive. Semen analysis may show nonspecific abnormalities, including a "stress pattern," with abnormal sperm forms and decreased motility. The Doppler stethoscope and ultrasonography may assist in making the diagnosis but are likewise nonspecific. Venography is frequently diagnostic, but is invasive and often difficult to do.

The radionuclide demonstration of a varix is accomplished by labeling a patient's erythrocytes with technetium Tc 99m pertechnetate, the same agent used in routine cardiac imaging (gated cineangiography). The patient's cells are labeled by an in vivo technique with two peripheral venous injections. A radionuclide perfusion study is done at the time of injection of the isotope to evaluate for evidence of certain disorders, particularly for hyperemia, which would indicate an inflammatory condition.

The scrotal "blood pool" is statically imaged within minutes after injection, with the imaging done anteriorly and with the use of median raphe markers and upright (standing) and Valsalva's maneuvers as provocative measures.

Because the testicles are relatively hypovascular organs, the diagnosis of a varicocele depends on showing increased blood pool activity surrounding the left testis relative to the right. Additionally, regions of interest are developed by computer over each hemiscrotum to quantitate scrotal vascularity. A difference (left versus right) of greater than 10% to 15% is considered significant. Quantitative analysis may be impractical in the approximately 15% of bilateral varices, however, and visual analysis occasionally difficult if symmetry is present.

In clinical experience, the radionuclide examination has better sensitivity when compared with clinical suspicion alone. It may also confirm suspected but unproved varix formation or the presence of bilateral varices. The test represents an improvement in the detection and diagnosis of varicocele formation and offers a noninvasive, risk-free and cost-effective approach to diagnosis in subfertile men.

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Preoperative Scintigraphic Location of Parathyroid Tumors

PARATHYROID SCINTIGRAPHY has recently been reevaluated after the appearance of reports from Italy on the use of technetium 99m and thallium 201 for locating parathyroid adenomas. Hyperparathyroidism is a common clinical problem and operative localization of such tumors is sometimes difficult, with 5% to 10% of operations failing to localize a parathyroid tumor. It would be desirable then to identify their location preoperatively if a simple, noninvasive technique were available.

The technique initially reported was modified such that 2 to 3 mCi of thallium 201 is first administered, followed by 5 to 10 mCi of technetium Tc 99m pertechnetate. The patient is imaged over the thyroid-parathyroid region and the data computer acquired. Color images are generated using a special computer-comparison technique. Both analog and computer-processed color images can be used for localization.

As previously reported, single parathyroid adenomas were successfully localized preoperatively in 88% of patients without a previous parathyroid operation and in 86% of those with adenomas not located at a previous surgical procedure. In all, 83% of glands with secondary hyperplasia, 66% with primary hyperplasia and one patient with carcinoma were detected. Both published analog methods and color-comparison dual-isotope scintigraphy exceed the reported sensitivities of either ultrasonography or computed tomography. Using the color-comparison method, 87% of ectopic parathyroid tumors are successfully localized and patients with forearm transplants can also be evaluated. Modest goiters do not interfere and normal or suppressed parathyroid glands are not seen.

The benefits of dual-isotope localization techniques include the following: aid in differentiating preoperatively between hyperplasia and adenoma, shortened surgical time (and dissection), which ultimately lowers operative costs, and ability to evaluate cases in which a previous operation has failed to locate the parathyroid abnormality. Published studies strongly support the use of preoperative localization of parathyroid tumors by nuclear scintigraphy.

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